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Reference No. 53-24

THE SURFACE OUTCROP OF THE GULF STREAM FRONT

By

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and
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Technical Report
Submitted to the Office of Naval Research
Under Contract N6onr-27701 (NR-083-004)

April 1953

Approved for Distribution _____
Director

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During 26-27 February 1953, an attempt was made to fly along the surface expression of the Gulf Stream front between Miami, Florida, and 70° W longitude. On this flight, as during the earlier flight made in November 1952 (Science, 1953), the Stommel-Parson airborne radiation thermometer was used together with photographic and visual observations to determine the position of the frontal outcrop on the sea surface. It was possible to follow phenomena apparently related to the Gulf Stream front throughout most of the distance between Miami and 70° W, but it was found that both the visual and thermometric evidence of the front was discontinuous. Figure 1 shows the manner in which the frontal outcrop was broken. When approaching a discontinuity, one had the experience that both the temperature gradient at the surface and the change of sea state and sea color coincident with the temperature change grew fainter as observations were pursued downstream until in each case none of these clues were sufficiently pronounced to direct the airplane further. It was learned in November 1952 that the frontal phenomena generally reappeared nearer shore. This was found to be so in every case on the more recent flight. The surface expressions of the Gulf Stream front are therefore considered to be

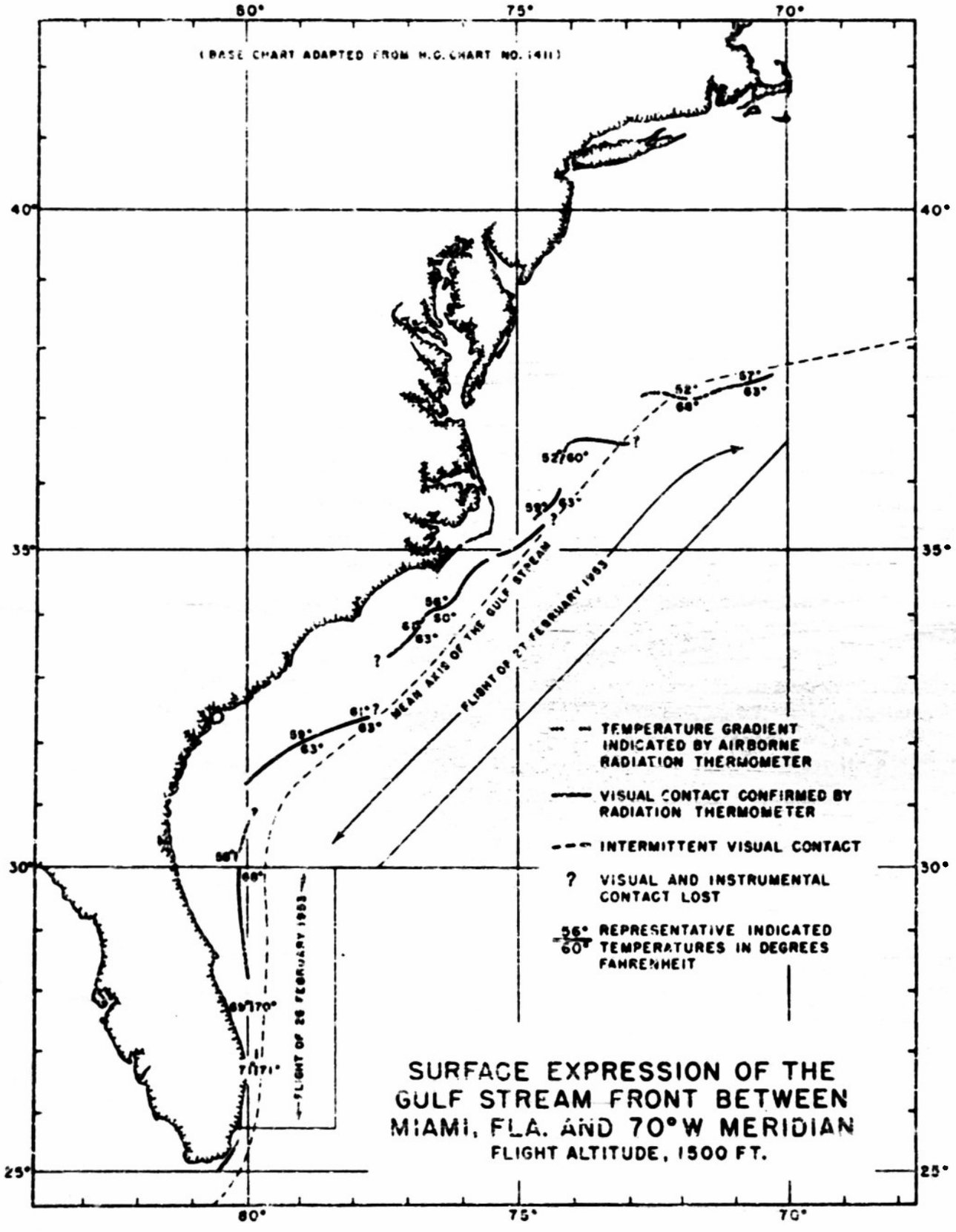
80°
75°
70°
(BASE CHART ADAPTED FROM H.O. CHART NO. 1411)
40°
35°
30°
25°
FLIGHT OF 27 FEBRUARY 1953
MEAN AXIS OF THE GULF STREAM
FLIGHT OF 28 FEBRUARY 1953
— — TEMPERATURE GRADIENT INDICATED BY AIRBORNE RADIATION THERMOMETER
——— VISUAL CONTACT CONFIRMED BY RADIATION THERMOMETER
— — — INTERMITTENT VISUAL CONTACT
? VISUAL AND INSTRUMENTAL CONTACT LOST
56°/60° REPRESENTATIVE INDICATED TEMPERATURES IN DEGREES FAHRENHEIT
SURFACE EXPRESSION OF THE GULF STREAM FRONT BETWEEN MIAMI, FLA. AND 70°W MERIDIAN
FLIGHT ALTITUDE, 1500 FT.

FIG. 1

a succession of traceable surface evidences arranged on echelon in a manner similar in many ways to the very large-scale pattern of the multiple Gulf Stream proposed by Fuglister, 1952, from evidence obtained by Bathythermograph in the upper 200 m layer.

At present it is difficult to understand how the surface evidence obtained from the air may be related to the meander structure such as that observed from shipboard (Fuglister and Worthington, 1951). It is quite possible, for example, that the discontinuities observed from the airplane are only superficial phenomena. It is also possible, however, that the relatively wide spacing between successive Bathythermograph observations and successive crosings by ships have led to a smoother representation of the frontal structure than is actually the case.

Observation from the airplane has also indicated a fine structure which interrupts the continuity of the frontal outcrop at intervals from 1/2 to 10 miles. When the weather is clear it is possible to fly across these individual irregularities without losing track of the larger-scale trend. Figure 2 shows some of these smaller features as they were observed near Cape Hatteras on 27 February 1953.

The validity of visual and radiant signals from the sea surface as a means for tracing the frontal outcrop of the Gulf Stream is open to some question. It is known, for example, that the steepest temperature gradients at the

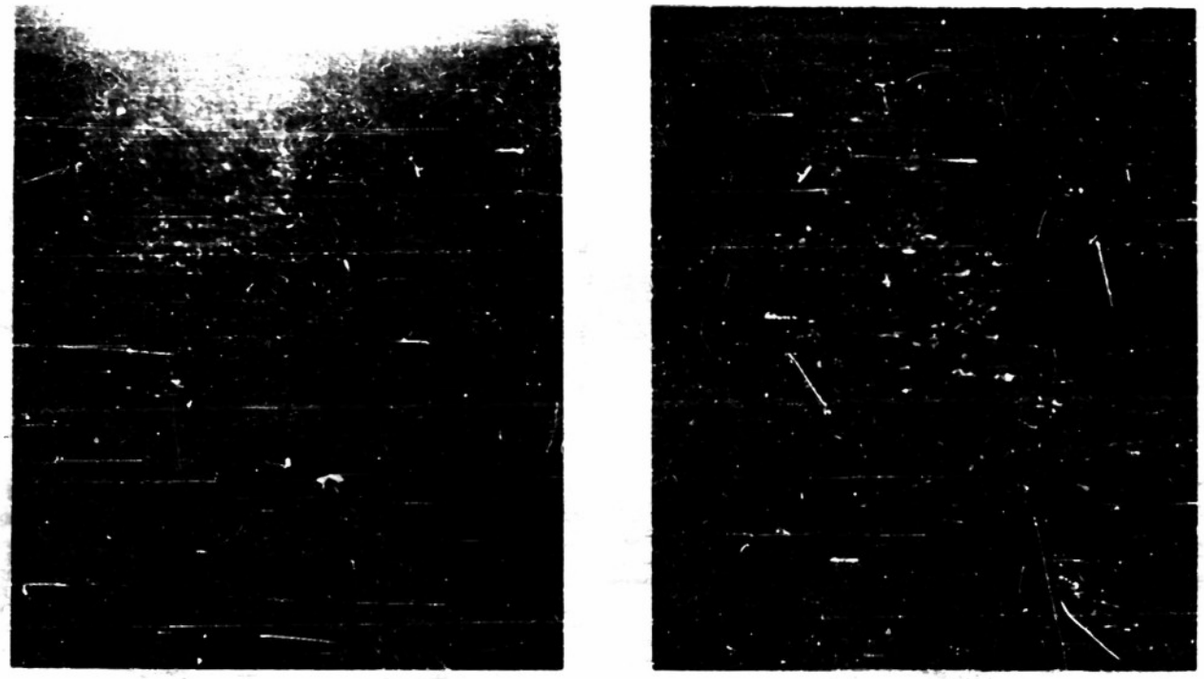

FIG.2

Appearance of the fine structure at the frontal outcrop seen off Cape Hatteras near 35°00'N, 75°00'W on 27 Feb 1953 from an altitude of 1500 feet. View toward Northeast. Wind force 3 (approx) from Southwest. Warm water on the right. Original exposure on Kodachrome.

Unusually marked change in sea state noted at the frontal outcrop on 27 Feb 1953 near 35°45'N, 74°20'W from an altitude of 1500 feet. View toward Northeast. Wind force about 4 from Southwest. Warm water on right, presumably moving with the wind. Original exposure on Kodachrome.

sea surface are usually found a few miles shoreward of the steepest horizontal gradients 100 to 200 m below the surface in winter and may be as much as 50 miles or more shoreward of the deeper temperature gradients in summer. Therefore, the evidence of the radiation thermometer alone is probably most reliable during the winter months. Visible evidence consists of a number of factors which include a change in the water color, a change in the sea state due to the horizontal shear of the surface currents, and possibly, accumulations of sargassum or, in calm weather, characteristic patterns of surface slicks. Slicks alone are unreliable indices of the front but when accompanied with a change in water color it is usually found that a strong temperature gradient is also associated. In rough weather the slicks are no longer visible but the sea state may change abruptly across the frontal outcrop (especially when near force 3) together with a change of water color and temperature. Therefore, the flights along the front are guided by an association of visible signs and evidence of an abrupt temperature change. From a study of Bathythermograph sections through Slope water it seems possible that these clues may remain useful from Cape Hatteras eastward during June and possibly early July before surface heating destroys the correlation of temperature gradients with the other physical factors. A trustworthy check has still to be made of the relationship between the frontal outcrop detected from the air with that established from shipboard.

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